



A new cluster mass proxy and galaxy evolution studies in clusters from the Dark Energy Survey

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DPF Meeting, Fermilab - 31 July 2017

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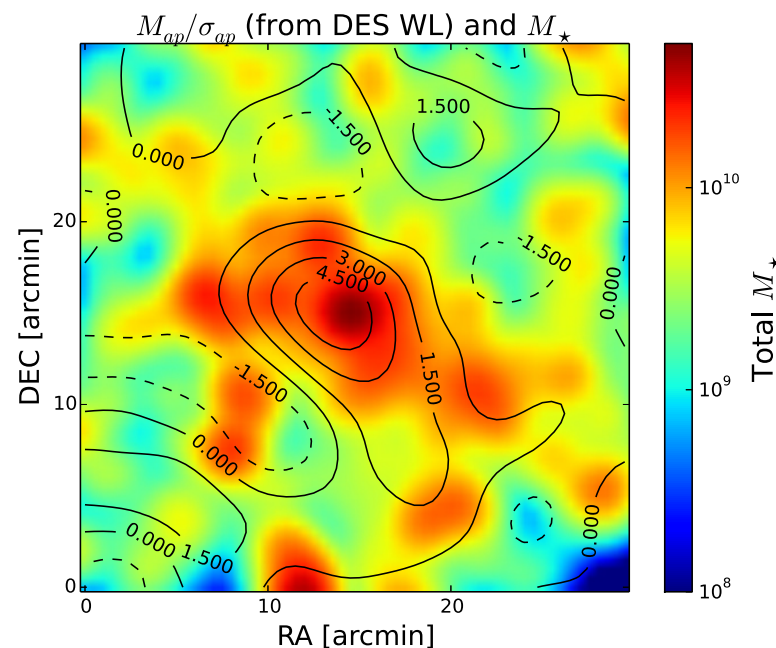


Introduction

- Voronoi Tessellation cluster finder (Soares-Santos et al. 2011): 2D tessellation in photometric redshift shells
- VT mass proxy shows high scatter in richness- ξ (Saro et al. 2015) - important for cluster cosmology!
- Develop a new mass proxy for VT, that is not red-sequence based
- Mass proxy based on cluster galaxies stellar masses

$$\mu_{\star} = 10^{-10} \sum_i p_{\text{mem},i} M_{\star,i}$$

- All results are unpublished and preliminary

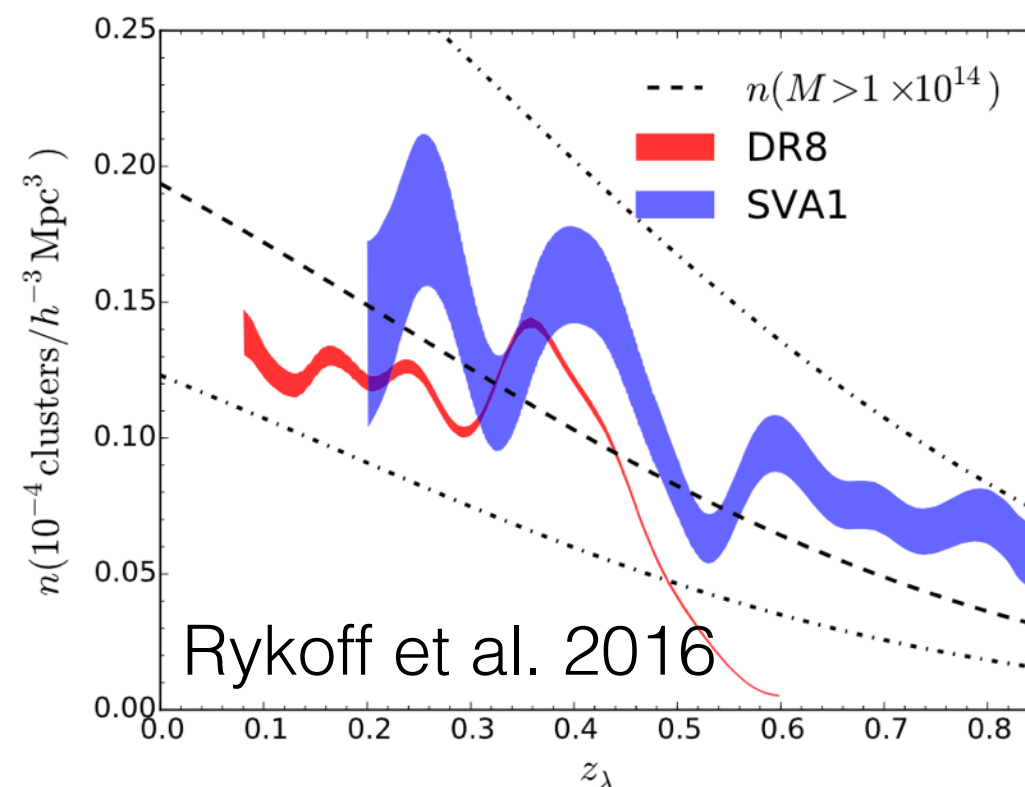
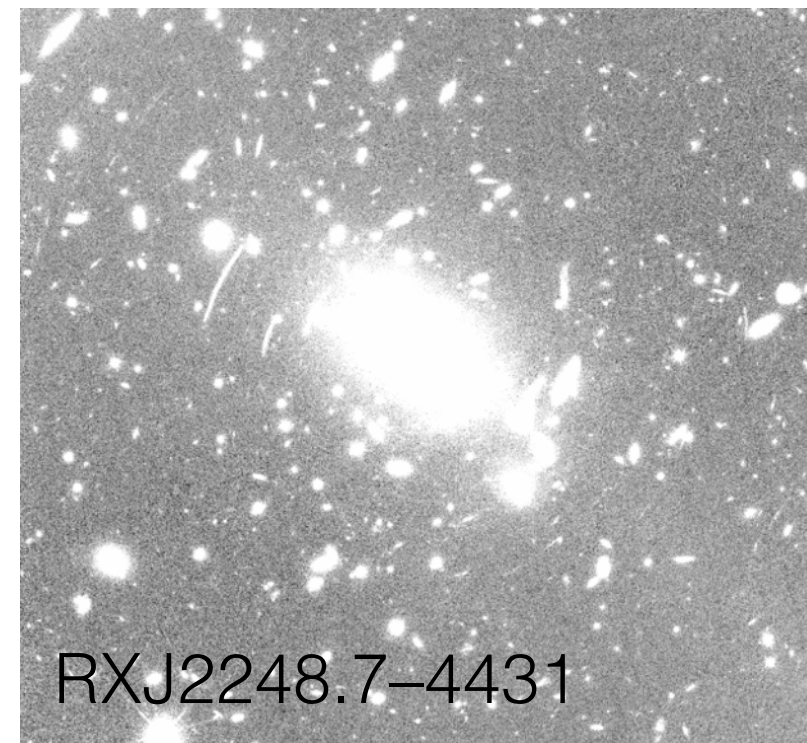


- Stellar mass is a good mass proxy for halo mass
- It can be reliably estimated with DES data within clusters (Palmese et al. 2016)



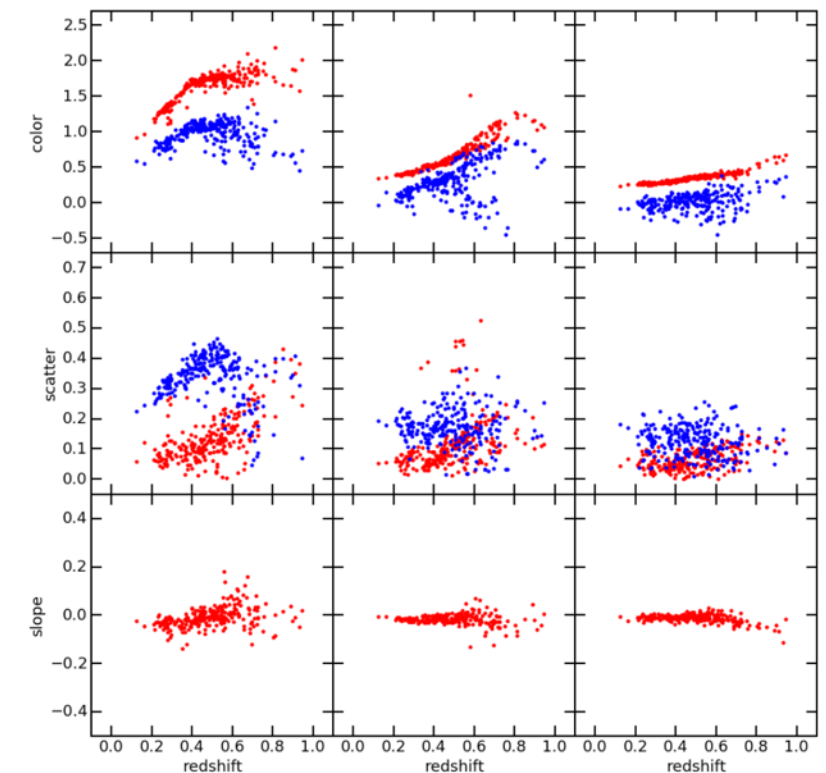
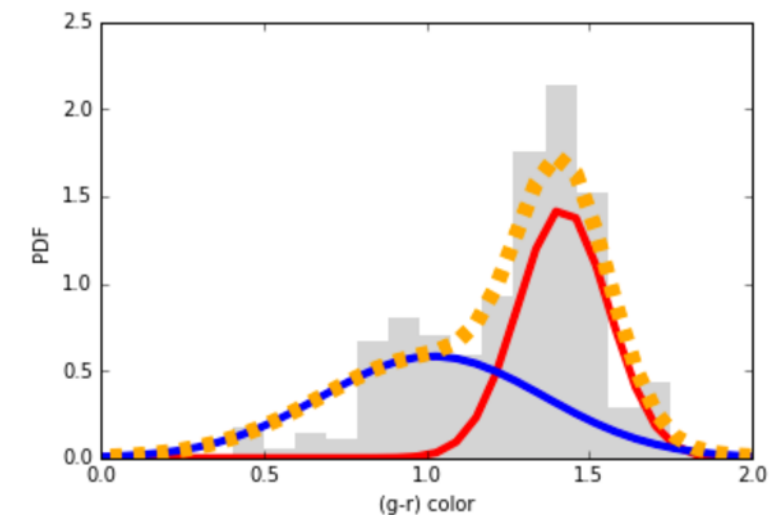
Clusters sample

- Results showed here: redMaPPer Year 1 clusters.
- VT cluster catalogs under production for DES and BLISS
- redMaPPer is a cluster finder that identifies clusters by means of the red sequence
- cosmology sample: $\lambda > 5$, volume limited, $\sim 87\text{k}$ clusters, up to $z \sim 0.7$
- full sample: $\lambda > 20$, ~ 8000 clusters up to $z \sim 1$



Membership assignment and photometric properties of DES redMaPPer clusters

- Year 1 redMaPPer cluster center and redshift
- Select galaxies from the Year 1 galaxy catalog
- Assign redshift (from photoz), radial and color membership probability
- Halo Occupation Distribution model for M_{200} and R_{200} assignment
- Gaussian Mixture Modeling for red sequence and blue cloud
- RS color, width and slope measurement for ~ 8000 clusters out to $z \sim 1$



For more information:

**Photometric Properties and Stellar Masses of
Dark Energy Survey Galaxy Clusters**

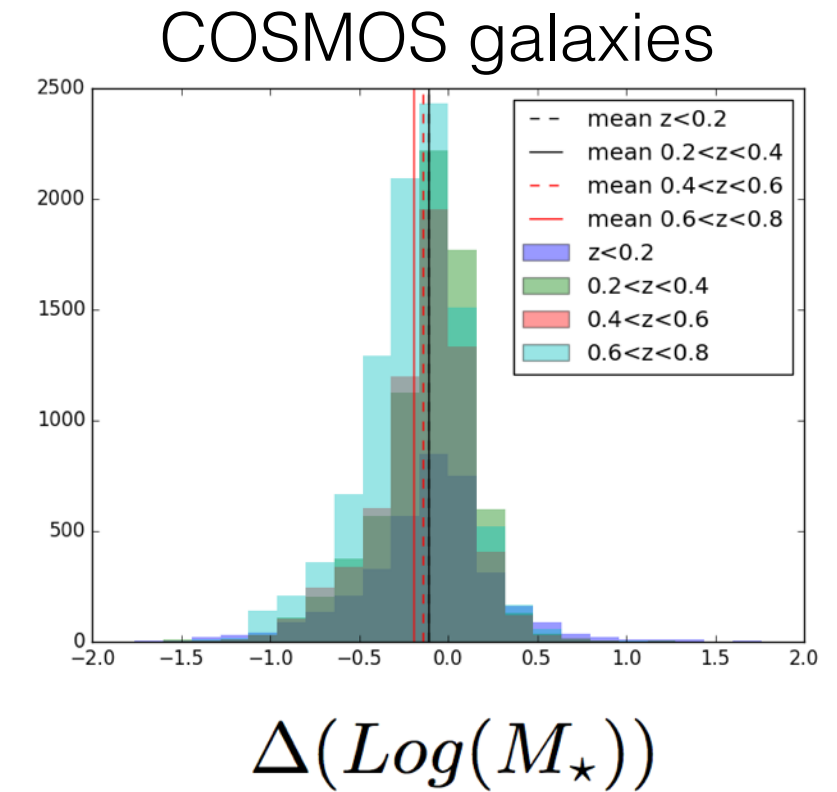
B. Welch, J. Annis, J. Burgad, H. Lin, A. Palmese, M. Soares-Santos,
and The DES Collaboration

Bayesian Model Averaging for galaxy stellar mass

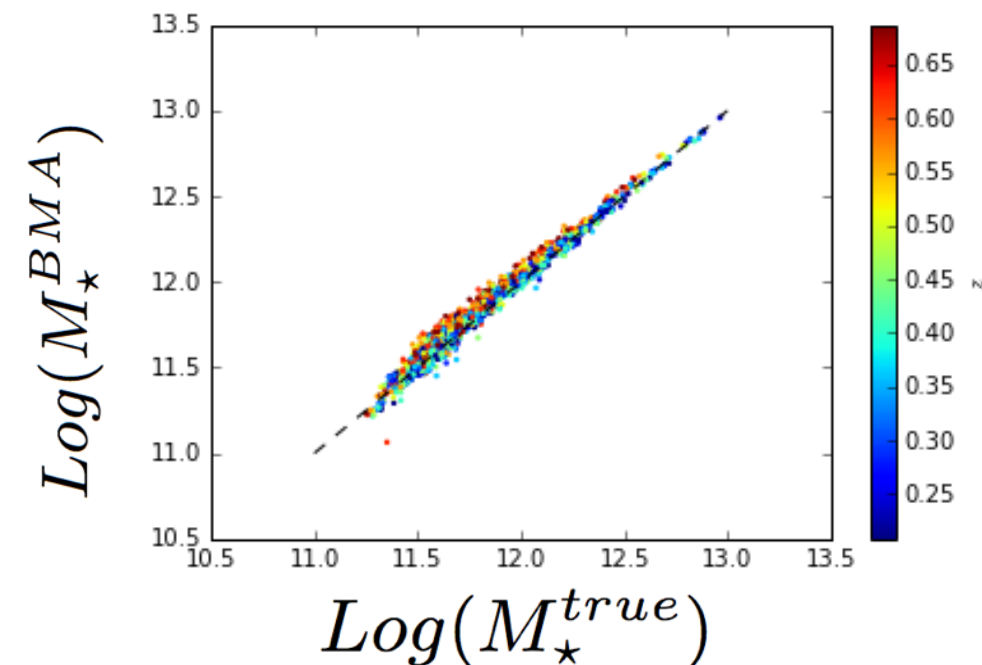
- FSPS (Conroy and Gunn 2010) synthetic models
- Padova 1994 isochrones, Chabrier IMF, Simha et al. SFH, 4 metallicities+ low metallicity addition
- Bayesian model averaging for M_* estimation

$$p(\Delta|D) = \sum_k p(\Delta|D, M_k)p(M_k|D)$$

- Validation with Y1 data against other surveys, methods and simulations

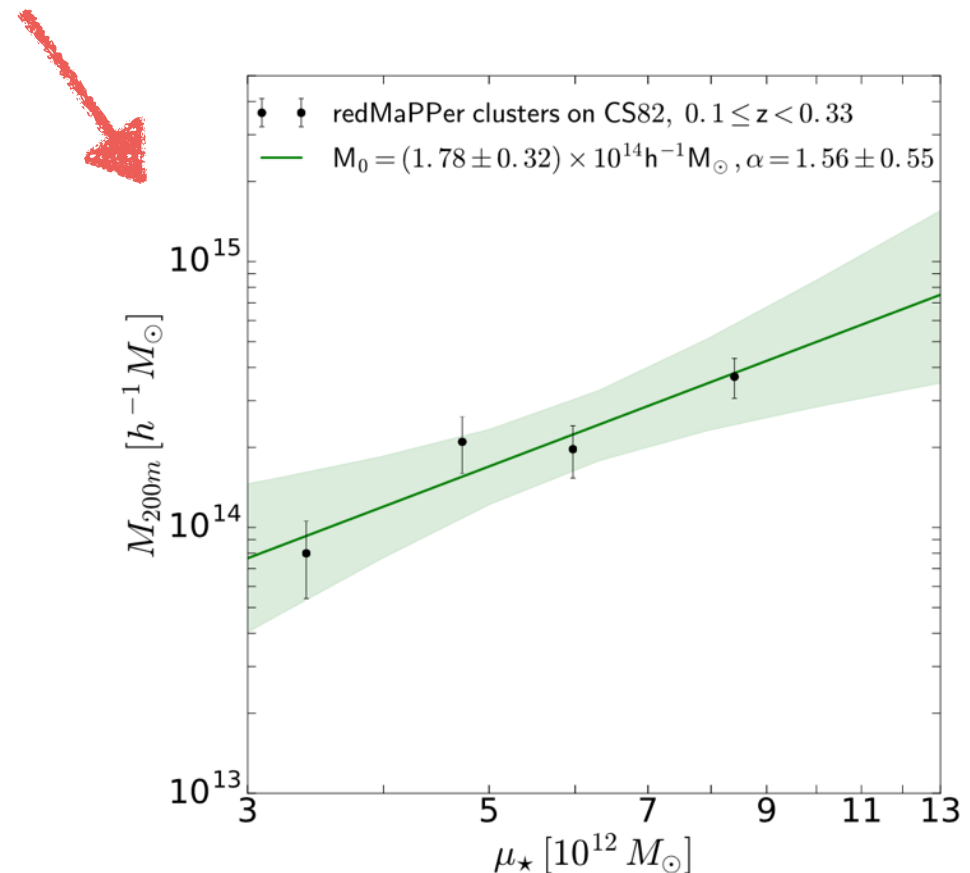
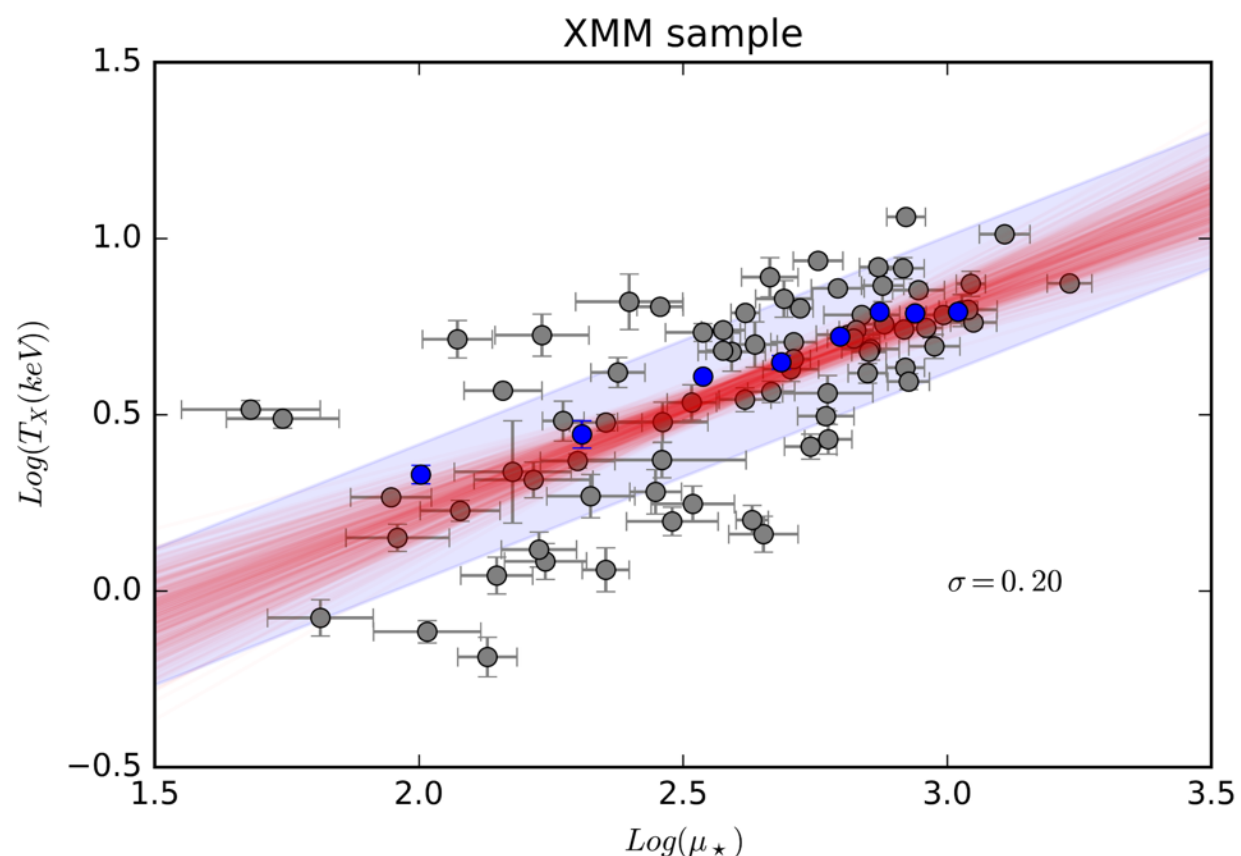


Millennium simulations
clusters



Calibrating μ_\star against other mass observables

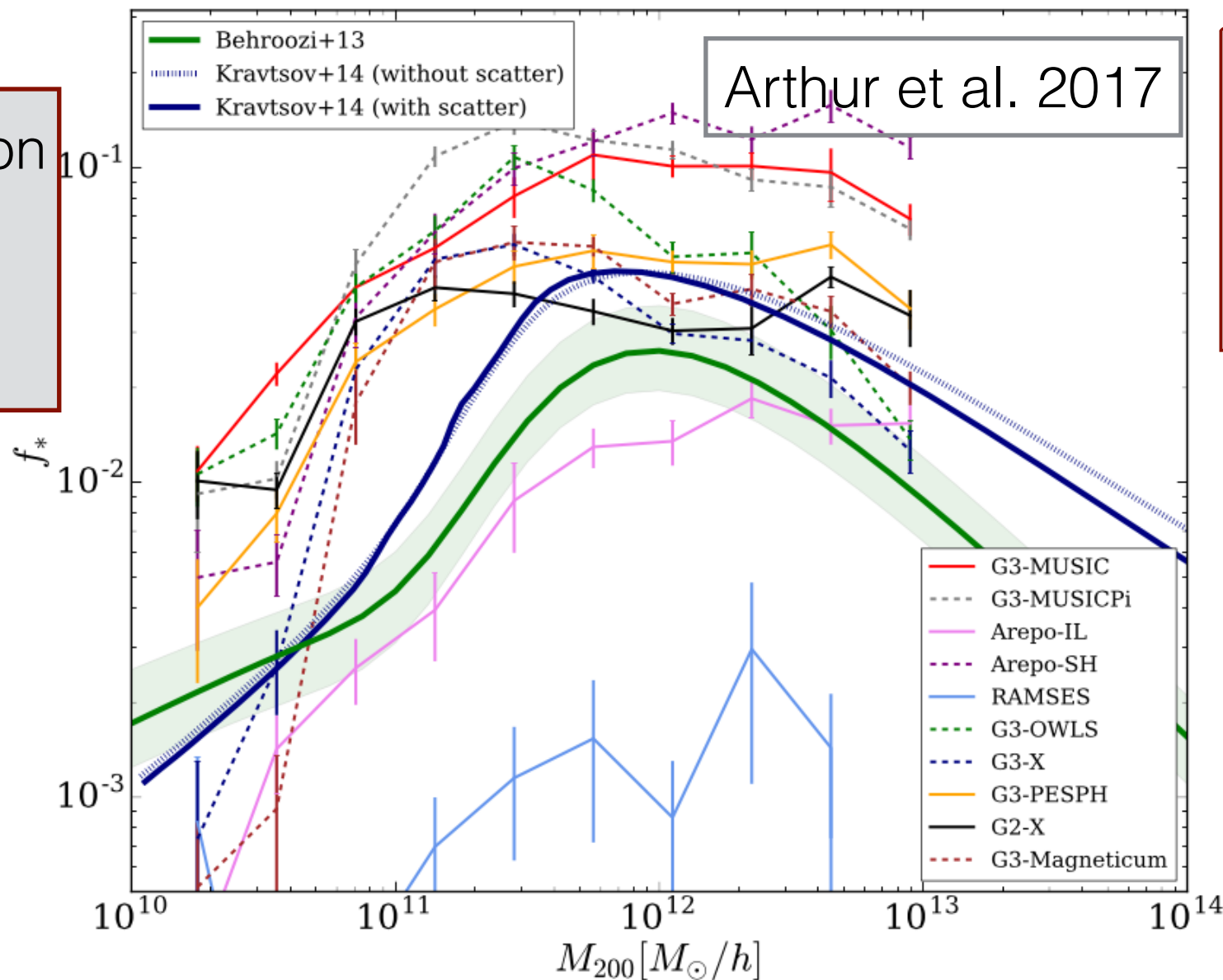
- XMM sample: ~200 clusters matching redMaPPer Y1, Chandra sample: ~90 clusters
- Bayesian linear regression $\langle \ln T_X | \mu_\star \rangle = \alpha + \beta \ln \left(\frac{\mu_\star}{\tilde{\mu}_\star} \right)$
- Inclusion of the blue cloud does not increase the intrinsic scatter
- Optimization of the radius: P_{rad} works well
- Tests on Millennium simulations also show promising scatter results
- Mass calibration on SDSS redMaPPer and VT clusters (Pereira et. al 2017, in prep.)



Stellar fractions and SHMR

Simulations and observations still mostly in tension

Over-production
of stars
in non-AGN
codes



Some codes
agree with
observations at
high mass

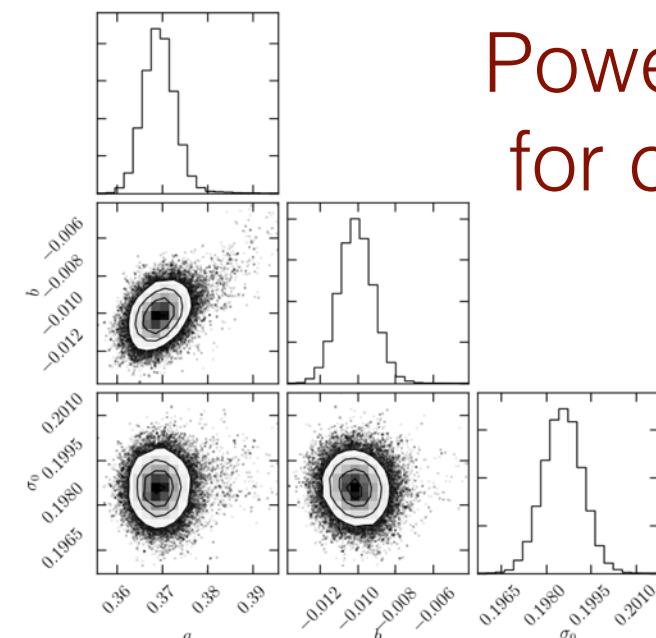
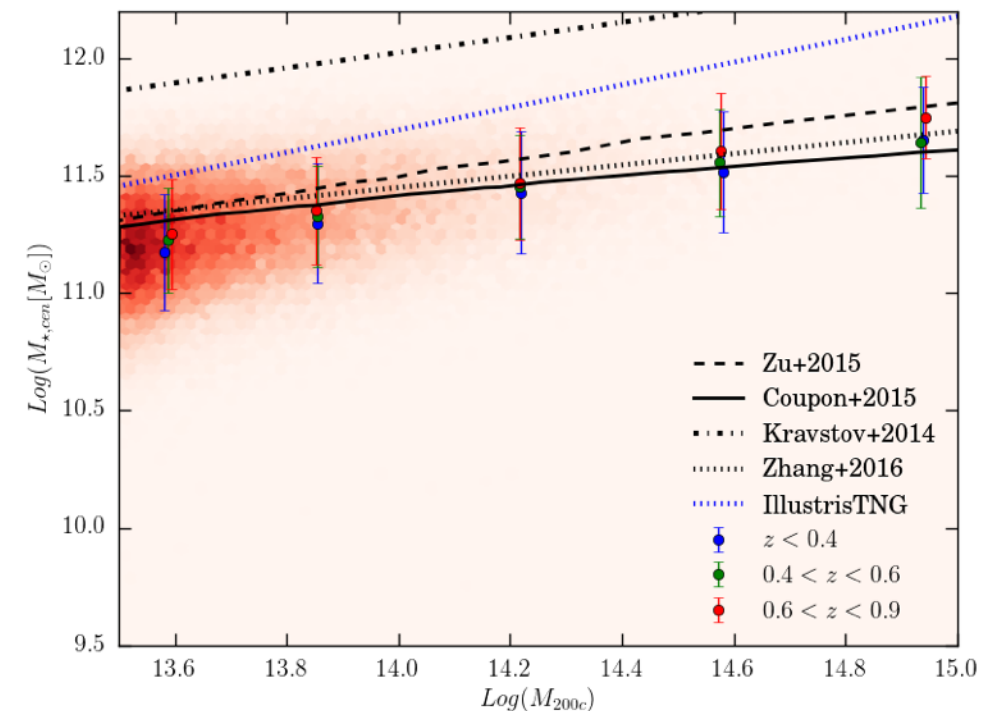
Star formation
efficiency
peaks around
Milky way-like
masses



Stellar to halo mass relation

Study whole Y1 redmapper by using lambda-mass relation from weak lensing calibration (Melchior et al., 2016) for an independent estimate of the halo mass

- Motivation: tensions between simulations and observations
- Measurement on huge sample compared to other results
- Cosmology sample
- Provide fits SHMR for total, central, satellites
- Consistent with other predictions/measurements

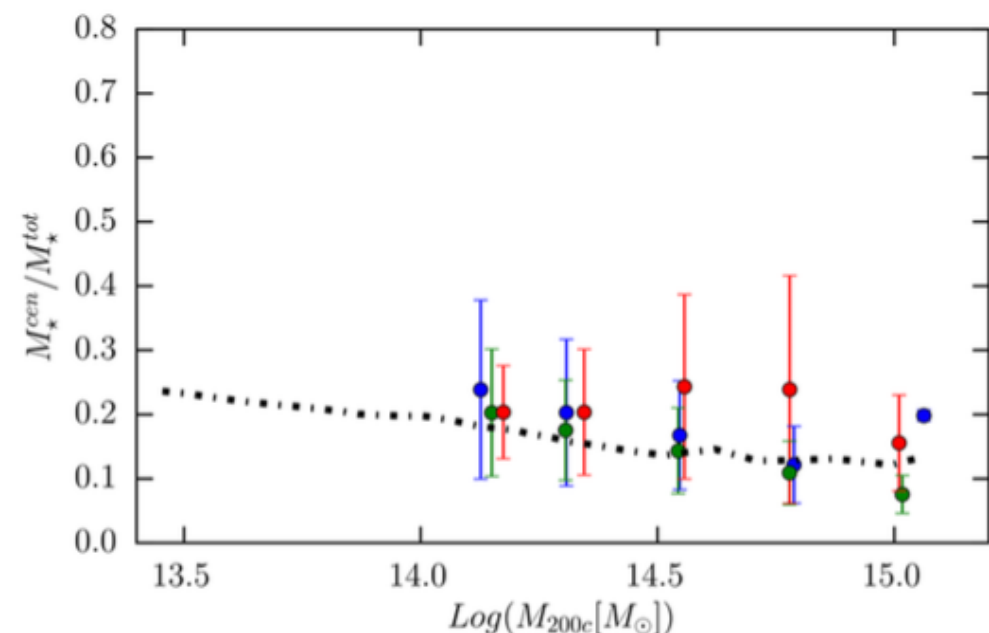
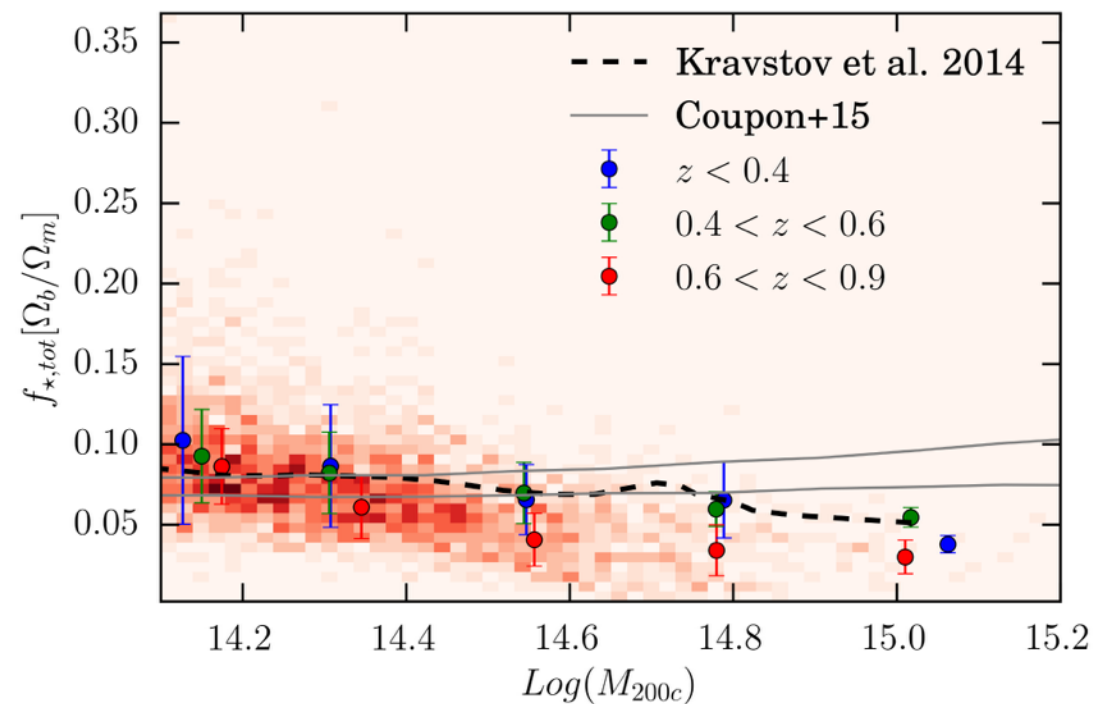


Power law fit
for centrals



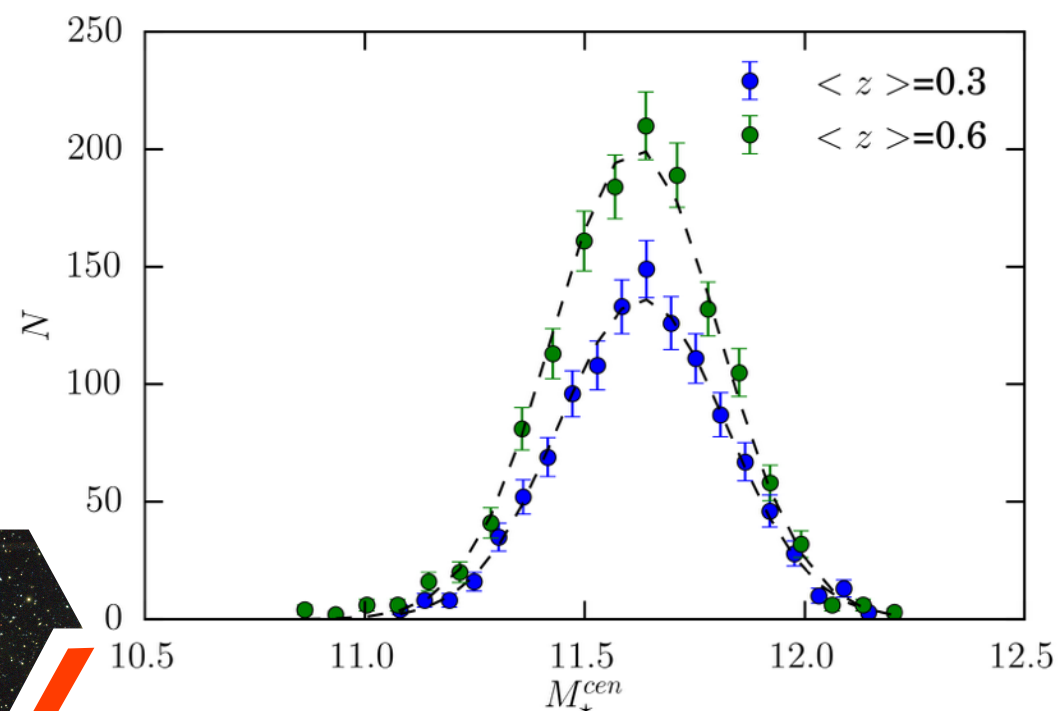
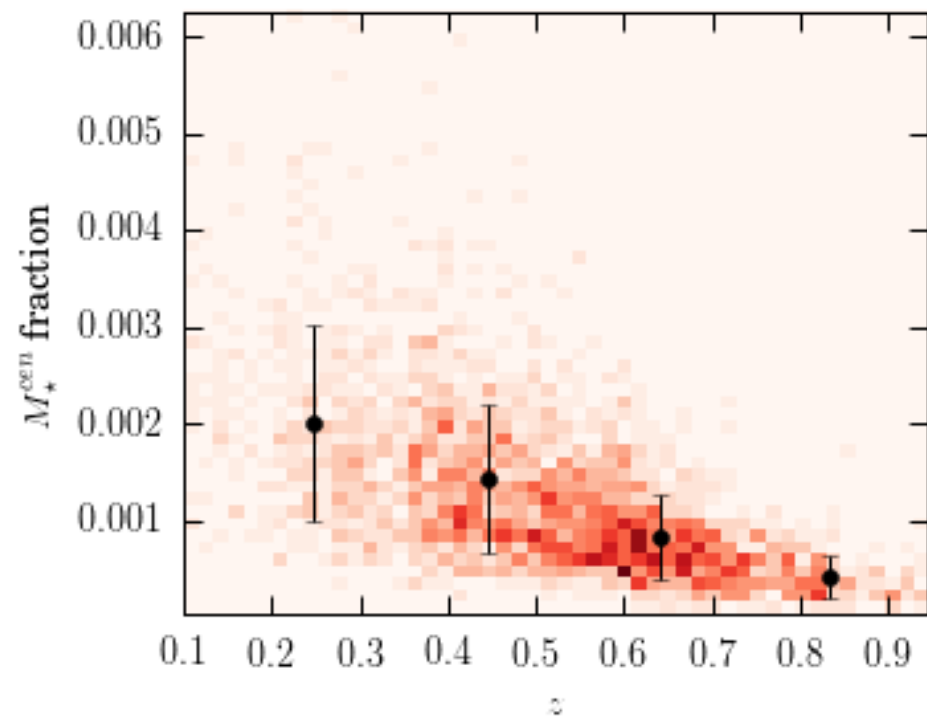
Stellar to halo mass relation

- Asymptotic **total** stellar mass fraction of $\sim 1\%$
- **Central** contributes to $\sim 20\%$ of the total stellar mass
- **Satellites** show a steeper and tighter correlation with halo mass
- Satellites 60-90% of total stellar mass around $M_{500} \sim 10^{14}$, $>80\%$ around $10^{15} M_{\text{Sun}}$



Central mass growth

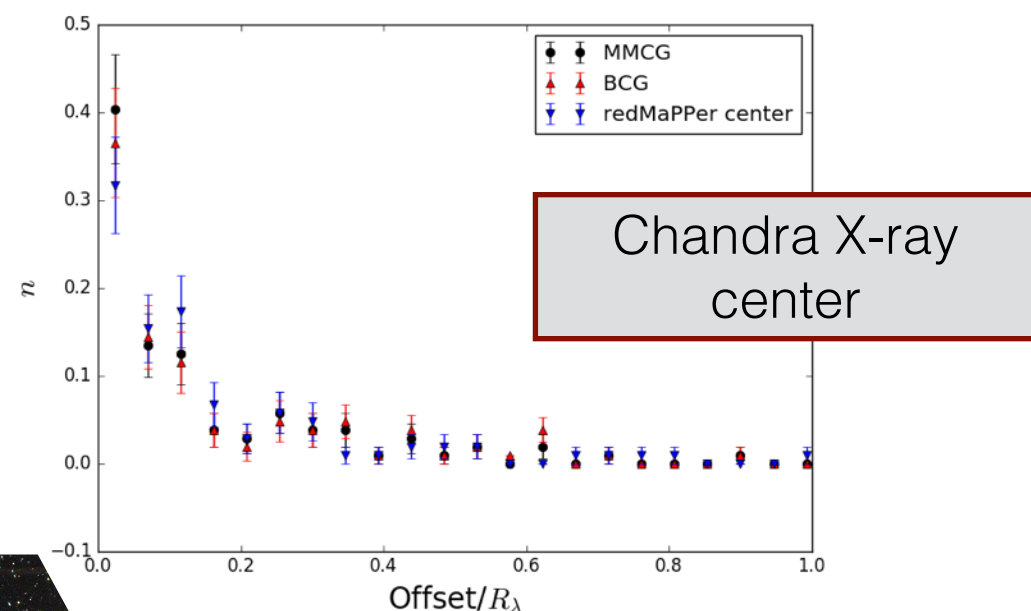
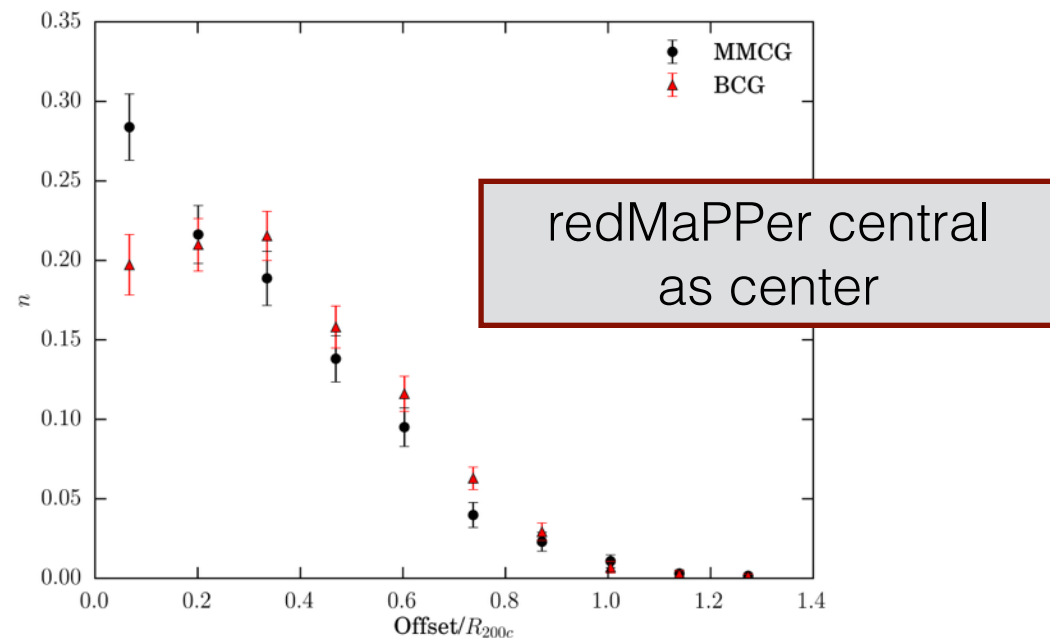
Corrected for central-halo mass correlation by dividing for halo mass



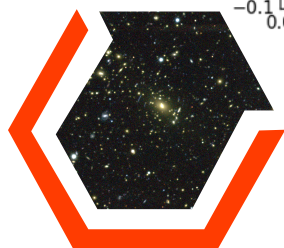
- Halo mass evolved up to $z=0$
- Growth of **factor ~ 4 consistent with semi-analytical models** (De Lucia+07)
- If evolution is not taken into account, growth ~ 2 (Lidman +12)
- **ICL** makes up 20-40% of the total cluster stellar mass. We want to estimate its contribution for DES clusters (ICL detection by Yuanyuan)
- **Log-normal mass function** of centrals

BCG or central?

BCG and central galaxy are not (always) the same object



- ~20% of centrals are not the most massive cluster galaxy (MMCG) in stellar mass, ~30% are not the BCG
- MMCG is a better proxy of central than BCG
- MMCG is a good proxy of the center of a cluster also when compared to X-ray centroids.



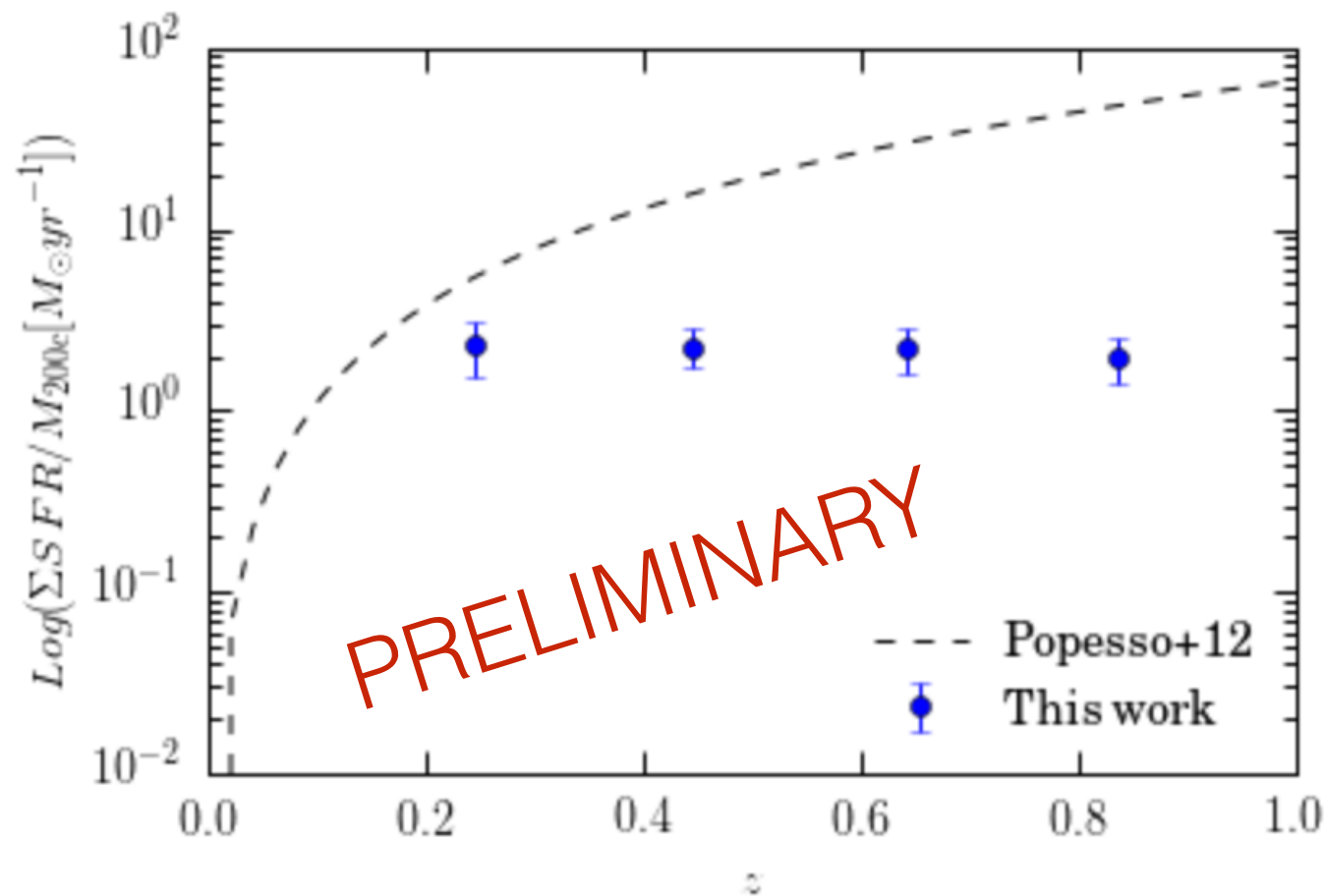
Conclusions

- Promising new mass proxy: low (0.2) scatter in $\mu-T_x$ relation and in μ -mass relation from simulations. Weak lensing calibration on SDSS (close to publication) and on DES Y1 (ongoing)
- Working on DES Y1 weak lensing calibration
- Interesting observable for cluster/galaxy evolution studies: star formation efficiency, blue fraction evolution..
- Working on SFRs, systematics
- Palmese et al. and Welch et al. papers in preparation



Total star formation rates

Evolution of the total SFRs of clusters per unit halo mass



- Understand quenching and Butcher-Oemler effect
- Total SFR per unit halo mass
- No significant redshift evolution
- Differences: use LIR, correct for low luminosity galaxies, 9 clusters
- Other works show no increase/slower increase (Behroozi+10)
- Sample selection problem

